

Biostimulants - Opportunities and Registration Challenges

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Definitions

- ▶ EU 2012: Plant biostimulants contain substances and / or microorganisms whose function when applied to plants or the rhizosphere is to **stimulate natural processes** to enhance / benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress and **crop quality**.
- ▶ **Proposed European Commission Definition:** “Plant biostimulant” means a product **stimulating** plant nutrition processes independently of the product’s nutrient content with the sole aim of improving one or more of the following characteristics of the plant: (a) nutrient use efficiency; (b) tolerance to abiotic stress; and **(c) crop quality traits**.

Definitions

- ▶ Proposed AAPFCO: “Biostimulants - Substances, including micro-organisms, that are applied to plant, seed, soil or other growing media that may enhance the plant’s ability to assimilate applied nutrients, or **provide benefits to plant development**. Biostimulants are non plant nutrients and therefore may not make any nutrient claims or guarantees.”

Definitions

- ▶ **2018 Farm Bill1:** For purposes of a report Congress directed USDA to prepare, “Plant Biostimulant” is considered a substance or micro-organism that, when applied to seeds, plants, or the rhizosphere, stimulates natural processes to enhance or benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, or crop quality and yield.
- ▶ **EPA Draft Document:** Generally speaking, a “plant Biostimulant” is a naturally-occurring substance or microbe that is used either by itself or in combination with other naturally-occurring substances or microbes for the purpose of stimulating natural processes in plants or in the soil in order to, among other things, improve nutrient and/or water use efficiency by plants, help plants tolerate abiotic stress, or improve the physical, chemical, and/or biological characteristics of the soil as a medium for plant growth.

Examples of Biostimulant Materials

Amino Acids

Protein Hydrolysates

Humic Acid

Fulvic Acid

Plant Extracts

Fermentation Broths

Microbes

Fungi

Jasmonic Acid

Phosphorous Acid

Chitooligosaccharides

Gamma Aminobutyric Acid

Glutamine

Carbohydrates

Chitin

Yucca Extracts

MiRNA

Abscisic Acid

Salicylic Acid

Brassinosteroids

Glycine Betaine

Seaplant Extracts

Biostimulant Technology Today

Modern science is being used to determine the biostimulant modes of activity as never before. Here is an example typical of the genre.

Micro RNA

To understand the molecular mechanism(s) of ANE-mediated stress tolerance, we looked at the differences in the miRNAs in Arabidopsis grown under optimal conditions, challenged with salinity stress and treated with ANE under salinity stress. Four small RNA libraries were constructed from leaves of Arabidopsis harvested at 1, 6 and 12h after exposure to salinity stress. The differential expression analysis of reads from the next generation sequencing revealed that **miR396a** was upregulated in plants treated with ANE in the presence of salt as compared to the plants treated with salt alone. The higher expression of miR396a negatively regulated the expression of **AtGRF7**, which in turn lead to higher expression of target genes **AtDREB2a** and **AtRD29**. Additionally, ANE treatment reduced the expression of **ath-miR169g-5p** which lead to induction of genes **AtNFYA1** and **ATNFYA2** that are involved in mediating salinity tolerance. Further, ANE improved phosphate uptake in the plants under salinity stress by regulating the expression of **athmiR399**, **ath-miR827** and their **target genes AtUBC24, AtWAK2, AtSYG1 and AtGALO**. This first-time research indicates that ANE mitigates salinity stress in Arabidopsis by differential regulation of miRNAs, and provides further insight into the molecular mechanism of action of the Biostimulant ANE.

Historical Landscape

Traditionally, Biostimulants have been secreted in fertilizers

This avoids some scrutiny but has serious pitfalls

USEPA has in the past fined companies claiming “Biostimulant Activity” as well as the distributors of the product

CDPR has successfully defended, in court, a large fine (\$784,000) against a company selling a seaplant extract by promoting PGR content in **adjuvants** and fertilizers

Historical Landscape

Numerous companies have demonstrated yield and quality improvements from the use of biostimulants

Many of these technologies really provide economic benefits to growers

The lack of a framework to communicate publicly these results relegates them into the “Snake Oil” class

Growers and researchers are hampered by pervasive misinformation due to a lack of proper oversight of claims

Fertilizer Laws and Regulations

Association of American Plant Food Control Officials (AAPFCO) publishes national fertilizer regulatory guidelines annually for use by states

In 2015 AAPFCO tried to define “Biostimulant” to allow states to determine the suitability via data for inclusion in labeling

Proposed AAPFCO: “Biostimulants - Substances, including micro-organisms, that are applied to plant, seed, soil or other growing media that may enhance the plant’s ability to assimilate applied nutrients, or provide benefits to plant development. Biostimulants are non plant nutrients and therefore may not make any nutrient claims or guarantees.”

USEPA dissuaded them from proceeding, noting the term “Stimulant” belonged in their purview as requiring FIFRA registration as Plant Growth Regulators

2018 Farm Bill Mandate to EPA

Language included in Farm Bill seems to direct USEPA to determine a pathway to allowing Biostimulants use and promotion.

Recently a draft guideline was published for comment as:

“Draft Guidance for Plant Regulator Label Claims, Including Plant Biostimulants”

EPA Examples of Allowed Nutrient Based Claims

- ▶ Avoids/corrects/prevents nutrition-based/nutrient deficiency-based plant disorders (e.g. chlorosis, etc.)
- ▶ Improves soil/nutrient conditions for better plant/crop size/yield and overall plant mass
- ▶ Improves/supports asymbiotic/symbiotic microbial associations with plant roots and rhizosphere
- ▶ Improves/Optimizes soil/nutrient conditions for root and plant growth and seed germination
- ▶ Optimizes conditions for tolerance of/resistance to abiotic stress

EPA Examples of Allowed Inoculant-Based Claims

- ▶ Enhance/improve/support/beneficial microbes in rhizosphere/soil microbiome
- ▶ Increases overall plant mass by improved nutrient uptake
- ▶ Increases/improves/optimizes conditions for tolerance of/resistance to abiotic stress by improved nutrition
- ▶ Improve/increase/support biodegradation of organic matter
- ▶ Improve/increase/support availability/release of bound nutrients from the soil
- ▶ Improve nutrient/water transport/uptake/efficiency by plants/roots
- ▶ Improve/support mycorrhizal/rhizobial association/symbiosis with plant roots
- ▶ Improve/support nodulation
- ▶ Improves Phosphorus solubilization/availability for improved uptake
- ▶ Reduces Phosphorus loss to the environment
- ▶ Reduces/protects against abiotic stress by improved nutrient/water uptake/availability

EPA Examples of Allowed Soil Amendment-Based Claims

- Buffers/changes soil pH or changes cation exchange capacity (CEC)
- Helps condition the soil for improved plant performance
- Increases/improves/optimizes soil conditions for increased plant vigor
- Increases/improves/optimizes conditions for tolerance of/resistance to abiotic stress
- Improves/increases water/nutrient availability/use efficiency/processing/retention
- Improves/increases soil/water nutrient retention/holding capacity/permeability
- Provides/supplies organic matter
- Reduces leaching or soil compaction
- Supports beneficial microbes/augments activity and function of beneficial microbes

EPA Examples of Claims Triggering PGR Registration

- ▶ Enhances/promotes/stimulates/inhibits fruit or plant growth & development
- ▶ Promote stem elongation
- ▶ Root/shoot stimulator
- ▶ Stimulates cell division, cell differentiation & cell enlargement
- ▶ Accelerates, controls or delays abscission, development, ripening or senescence

EPA Examples of Claims Triggering PGR Registration

- ▶ Induce/promote/retard/suppress flowering ,bud break or seed germination
- ▶ Alters/improves plant/tree shape/structure
- ▶ Enhances/promotes crop/fruit/produce color/growth & development/quality/shape
- ▶ Fruit and nut thinner/sizer
- ▶ Inhibits/promotes sprouting or controls suckering

EPA Listed Ingredients Triggering PGR Registration

- ▶ Abscisic Acid (ABA)
- ▶ *gamma*-Aminobutyric Acid (GABA)
- ▶ 6-Benzyladenine (6-aminopurine; a cytokinin)
- ▶ Choline
- ▶ Complex Polymeric Polyhydroxy Acids (including Humic acid, fulvic acid, tannins; & organic acids from Leonardite)
- ▶ Corn glutens/Corn gluten meal
- ▶ Cytokinins (as all isopentenyladenine and zeatin derivatives)
- ▶ Cytokinin (as kinetin)
- ▶ Ethylene
- ▶ Gibberellic Acid A3 (GA3)
- ▶ Gibberellins A4/ A7 (GA4+7)
- ▶ L-Glutamic Acid
- ▶ Harpin proteins
- ▶ Homobrassinolide

EPA Listed Ingredients Triggering PGR Registration

- ▶ Indole-3 Acetic Acid (IAA)
- ▶ Indole-3-Butyric Acid (IBA)
- ▶ Jasmonates (includes all derivatives of jasmonic acid)
- ▶ Lysophosphatidylethanolamine (LPE)
- ▶ Laminarin
- ▶ Potassium silicate
- ▶ 1-Octanol
- ▶ Seaweed Extracts
- ▶ Sodium o-nitrophenolate
- ▶ Sodium p-nitrophenolate
- ▶ Sodium guaiacolate

A number of these are allowed in soil application but not in foliar applications. These include Humic, Fulvic, Harpin Protein, Potassium Silicate.

The inclusion of Seaweed Extracts may dramatically impact many companies and product lines.

So Where Does This Leave Us?

- ▶ Still much confusion about what can be on a label
- ▶ Biostimulants will continue to be hidden ingredients in many products
- ▶ The “AWESOME” claim will continue to be popular
- ▶ Growers and field consultants will still recommend their use
- ▶ The economic opportunities will drive the current technologies and development of new ones

So Where Does This Leave Us?

- ▶ Products which DO achieve FIFRA registration will require efficacy data
- ▶ CDPR has refused to register based on their review of this in the past
- ▶ The DRAFT GUIDELINE has possibly made it MORE difficult to market biostimulants
- ▶ State fertilizer regulators may be able to cite this as reason to disallow label claims regarding ingredients
- ▶ Nothing is likely to change from the Status Quo of today anytime soon

Questions?

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